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ONTARIO HYDRO AIR, AEROSOL, AND
PRECIPITATION MONITORING NETWORK
ASSESSMENT AND UPGRADING

Report No 82-484-K

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ABSTRACT

Ontario Hydro has operated an air, aerosol, and precipitation monitoring network in Ontario since 1975. The survey has undergone a number of modifications with regard to equipment, sampling sites, operating schedules and analytical techniques since its inception. Concern with the quality of the information obtained from the network, the compatibility of the data with those from other surveys and the need to maximize the effective operation of the survey has existed for some time. Manpower was finally available in 1981 to carry out an indepth assessment of the network. Ontario Hydro Research Division Report C81-153-K described the assessment and upgrading up to the middle of the project. This document describes the final results of the assessment and upgrading as originally planned. Some remaining problems and recommendations for future work are also discussed.

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TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
2.0 ASSESSMENT PROGRAM	1
3.0 THE RESULTING UPGRADED NETWORK	2
3.1 Sites	2
3.2 Sampling Equipment	2
3.2.1 Precipitation Samplers	2
3.2.2 Precipitation Gauges	4
3.2.3 Air and Aerosol Samplers	4
3.2.4 Air and Aerosol Sampling	7
3.3 Sampling Schedules	7
3.4 Sample Analysis	7
3.4.1 Precipitation Samples	7
3.4.2 Air and Aerosol Samples	8
3.5 Meteorological Information	8
3.6 Data Handling and Reporting	10
4.0 REMAINING TASKS AND PROBLEMS	10
5.0 CONCLUSIONS AND RECOMMENDATIONS	11
APPENDIX 1	14
APPENDIX 2	17
APPENDIX 3	
DISTRIBUTION	last page



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To Mr. F.J. Kee
Director of Research

ONTARIO HYDRO AIR, AEROSOL, AND PRECIPITATION MONITORING NETWORK ASSESSMENT AND UPGRADING

1.0 INTRODUCTION

Acidic precipitation is falling throughout the Province and is most acidic in southern Ontario. Ontario Hydro, through the use of coal-fired thermal generating stations, is a contributor of emissions that are precursors of acid rain. In an effort to gain insight into the problem of acid rain, Ontario Hydro has operated a monitoring network in Ontario to determine the spatial and temporal variations in air, aerosol and precipitation composition. This information helps define the nature of the problem and in focussing other work (mechanistic studies and modelling) aimed at placing Ontario Hydro's contribution to the overall problem in perspective.

The network has undergone several changes in terms of field equipment, sampling sites used, operating protocol, sampling methodology and analytical techniques. In 1981 the entire air and aerosol monitoring segment of the survey was changed and an intercomparison with the Ontario Ministry of the Environment (OME) and the Atmospheric Environment Service (AES) of Environment Canada was undertaken. The two events were part of a general effort to assess and upgrade our operation and to eliminate known deficiencies. By doing this we hoped to answer whether we were operating the best available network within the internal and external constraints imposed on us. Furthermore we wanted to establish whether the information garnered from our network could be confidently integrated with the results from other agencies and whether the upgraded survey conformed to the recommendations in recent published reports dealing with the rationale for quality sampling/1,2/.

The first phase of the assessment and upgrade has been reported in a recent Ontario Hydro Research Division Report, C81-153-K. The purpose of the present document is to describe and summarize the final results of the assessment and upgrade and to recommend the necessary tasks to complete the program.

2.0 ASSESSMENT PROGRAM

The Ontario Hydro network was assessed against the concept of the "ideal networks" as described in two recent publications/1,2/. Some of the main points for assessment are outlined below.

The Ontario Hydro survey objectives were reviewed. A clear definition of objectives is needed to make the proper monitoring site, sampling equipment, sampling frequency and sample preservation method selections. Individual sites were evaluated in terms of their regional representativeness, accessibility, power availability, sources of contamination, land use within the immediate area, obstructions, operator competence and Ontario Hydro financial constraints. Survey sampling equipment was appraised with regard to ruggedness, inertness to the chemical species of interest, automation of the equipment, response to events, completeness of collection and preservation of samples. Operator competence was judged by the ability to follow and execute the field instructions and by the quality of the results obtained from the various sites. All stages of the sample handling process were evaluated for possible sources of contamination due to operator handling, transport methods, laboratory handling and storage of samples. Laboratory analyses were reviewed in terms of sensitivity, detection limits and applied techniques of analysis as compared to those of other agencies. The quality assurance and quality control exercised during the processing of field samples was reviewed. Data handling was examined for consistency, ease of access and ease of manipulation for future uses.

3.0 THE RESULTING UPGRADED NETWORK

3.1 Sites

The locations of the six sites that were evaluated for the monitoring network are shown in Figure 3.1. The detailed site descriptions are presented in Appendix I. All of the Ontario Hydro sites were deemed satisfactory during the assessment with the exception of Essex. The immediate area surrounding the samplers at the Essex site had deteriorated to the point that the likelihood of sample contamination had increased to an unacceptable level. As a result, air, aerosol and precipitation sampling at Essex was discontinued. Prohibitive operator and maintenance expenses prevented Ontario Hydro from siting the Essex samplers at the OME Longwoods site. The daily sampling results from the OME/AES equipment at the Longwoods Conservation Authority site will be available for use by us. The surplus sampling equipment may be employed in various replication experiments at the other Ontario Hydro sites.

3.2 Sampling Equipment

3.2.1 Precipitation Samplers

The Sangamo Type A precipitation collector consists of two polyethylene containers symmetrically placed in a stainless steel body. A common lid is moved through by a driving mechanism to cover one or the other container. Two heated precipitation sensors mounted on a common support control the movement of the lid. When precipitation falls on to the sensor grids, a relay is energized and a motor is switched on, moving the lid from the precipitation container to the dry container. The motor is then switched off. When precipitation ceases, the electrically-heated sensor grids dry out, causing the relay to de-energize. The motor is switched on again and the cover is moved back onto the



FIGURE 3.1
ONTARIO HYDRO'S AIR, AEROSOL AND
PRECIPITATION SAMPLING NETWORK

precipitation collection container. The Sangamo sampler is designed to automatically expose the wet container only during periods of wet deposition. The Sangamo Type A, wet-only precipitation collector is one of the standard instruments used by other agencies such as the Ontario Ministry of Environment and the Atmospheric Environment Service to collect precipitation. Each of the Ontario Hydro sites is equipped with such a device; one is shown in Figure 3.2. As a result of the assessment program, a number of improvements in the collection system were recommended and made. To reduce the chances of contamination from operator handling, the precipitation collection bucket was lined with a polyethylene bag. This simplified the handling in the field, in transit, and in the laboratory. The bags were changed on a daily basis to further reduce the chances of sample contamination.

The reliability and durability of the Sangamo precipitation collector was also improved. Precipitation sensor overheating and meltdown was corrected by utilizing more reliable triacs in the heater circuits. Increasing the time delay between lid movements from twenty to one hundred and twenty seconds plus strengthening the clutch assembly, significantly reduced the number of mechanical failures among the collectors. Maintaining a spare pair of precipitation sensors and an extra controller board at each site also helped to reduce sampler downtime.

3.2.2 Precipitation Gauges

An electrically-heated rain and snow gauge for measuring precipitation volume and intensity is illustrated in Figure 3.3. Precipitation enters the gauge through an orifice and fills one of two small buckets located inside the housing. Each tip of a filled bucket triggers the momentary closure of a switch that marks the amount on an event recorder. Each mark is equivalent to 0.25 mm of rainfall. The outside case is electrically heated to melt frozen precipitation and to keep internal moving parts from freezing. A laboratory calibration of each gauge was undertaken prior to installation at Kapuskasing, Orangeville and Winchester. Precipitation intensity and volume were not available at these sites prior to the assessment. From the assessment it was decided to install additional insulation around the outside of the gauges for better winter operation.

3.2.3 Air and Aerosol Samplers

The original Sierra dichotomous sampling system was composed of two units, a control module and a sampling module as shown in Figure 3.4. During the first year of operation within the Ontario Hydro air, aerosol and precipitation network (OHAAPN) two major deficiencies with the sampling system became evident: (a) excessive vibration from the sampling pump as filter loading increased over the sampling period (24 h) caused damage to various internal components mainly due to inadequate shock-mounts on the pump and the very compact internal construction of the control module, and (b) an excessive amount of condensation occurred inside the sampling module hindering, and in some cases, preventing air flow through the sampler during periods of high humidity and cool temperature leading to loss of samples.

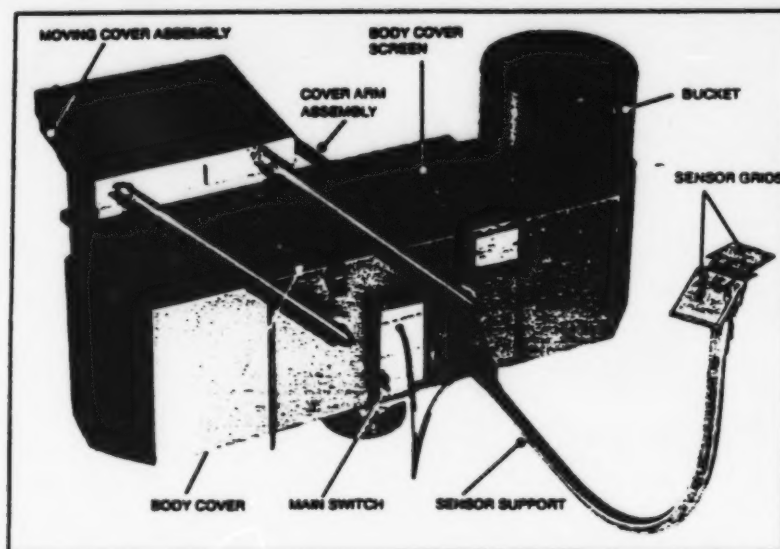


FIGURE 3.2

SANGAMO TYPE A PRECIPITATION COLLECTOR

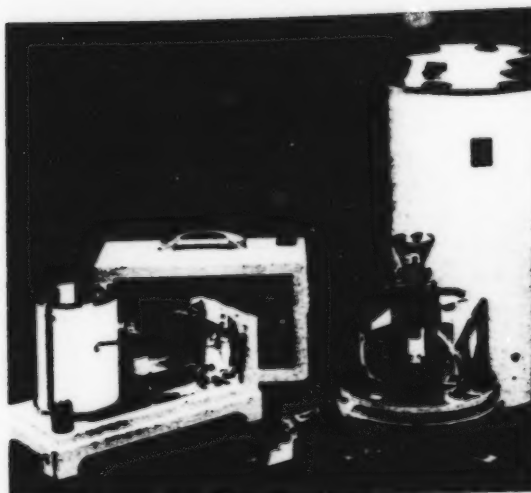


FIGURE 3.3

WEATHERTRONICS MODEL 6021 HEATED RAIN AND SNOW GAUGE



FIGURE 3.5

MODIFIED MODEL 244 SIERRA DICHOTOMOUS
SAMPLER AS OPERATED AT THE DORSET SITE

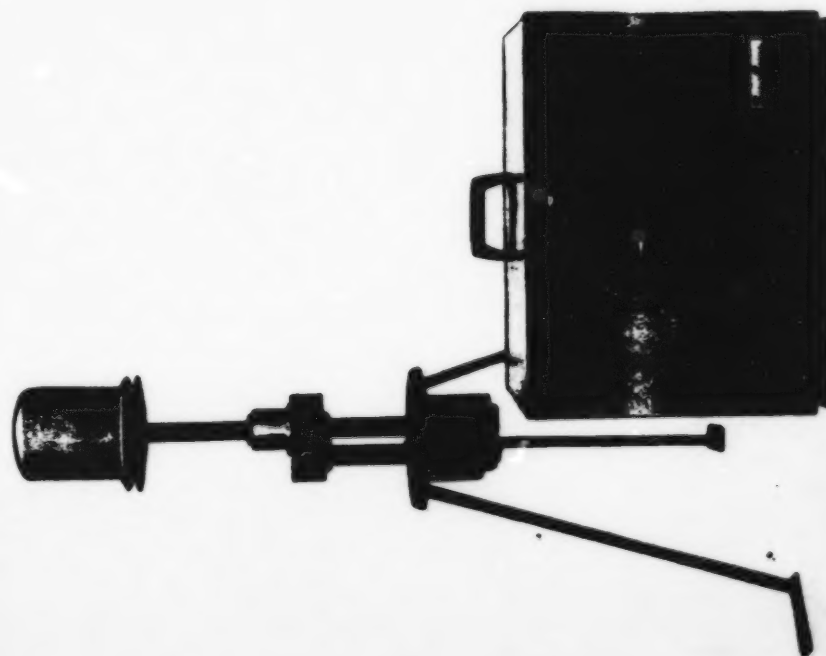


FIGURE 3.4

ORIGINAL DUAL MODULE MODEL 244
SIERRA DICHOTOMOUS SAMPLER

The network assessment recommended that the samplers be modified to eliminate the problems without affecting the sampling and the field protocol procedures. The two-module Sierra dichotomous samplers were reconstructed into single, temperature-controlled, easily-serviced and vibrationally-secure units. Figure 3.5 illustrates such a unit in operation at the Dorset site. A detailed description of the sampler modifications is given in Appendix 2.

3.2.4 Air and Aerosol Sampling

The modified Sierra dichotomous sampler size fractionates by virtual impaction, particles into two size ranges - 2.5 to 15 micrometers (coarse, non-respirable) and less than 2.5 micrometers (fine, respirable particles). Prior to the assessment, the fine particle stream filter cassette contained a 37-mm diameter, 1- μ m pore size, teflon filter for non-volatile aerosol collection, followed by a 37-mm diameter, 1.1- μ m pore size nylon filter for collection of volatile nitrates and nitric acid vapour and terminated by a 37-mm diameter potassium carbonate-impregnated Whatman 41 filter for sulfur dioxide collection. The coarse particle stream contained a single 37-mm diameter, 1- μ m pore size teflon filter for non-volatile aerosol collection. After the assessment, a 37-mm diameter, 1.1- μ m pore size nylon filter was added to the coarse size filter cassette to allow collection of samples that could be used to calculate total nitrate concentration. Operator comments during the assessment with regard to filter cassette sealing problems led to the replacement of all the filter cassette retaining rings in the network with new rings having additional mounting threads. Teflon lubricant was also applied to the threaded portions of the rings and sampling head to improve the field handling for the operators.

3.3 Sampling Schedules

The sampling protocols for both precipitation and air/aerosol sampling were reviewed during the survey assessment. Presently the Wet-only Sangamo Type-A precipitation collectors are operated from about 0800 EST to about 0800 EST of the following day, except on weekends, when the sample is collected from 0800 EST Friday to 0800 EST on Monday. Similarly, the modified Sierra dichotomous samplers are operated from approximately 0800 EST to about 0800 EST of the following day during weekdays. No samples are collected on weekends except for the Mississagi site which does have an operator available during the weekends. Both operating schedules were deemed satisfactory and correlated well with the protocols followed by the OME and AES in their respective daily sampling networks.

3.4 Sample Analysis

3.4.1 Precipitation Samples

The analysis of precipitation samples continued to involve the application of ion chromatographic methods for the anions, auto-analysis techniques for ammonium ion, atomic absorption spectroscopy for the cations and a glass electrode determination for pH.

The entire list of parameters measured includes: catch of sampler, pH, SO_4 , NO_3 , Cl^- , NH_4^+ , Ca^{2+} , Mg^{2+} , Na^+ and K^+ . The methods used to analyze the precipitation samples are described in Ontario Hydro Research Division Reports 78-159-K and 79-70-K. Each of the methods has been verified by various government agency laboratories through intercomparison programs. The Analytic Services Section of Ontario Hydro is using the above analytical methods to analyze the OHAAPN precipitation samples. Precipitation samples with poor ionic balance (>20% deviation) have the analysis repeated, samples with pH values below 4 have acidity titrations performed on them if sufficient sample is available and a species priority of pH, SO_4 , NO_3 , Cl^- , NH_4^+ , Ca^{2+} , Na^+ , Mg^{2+} , and K^+ for analyses of small volume samples has been set to obtain consistent analytical reports.

3.4.2 Air and Aerosol Samples

During the survey assessment a need to improve the analytical sensitivity of the filter analyses performed with the autoanalyser was recognized. Detailed descriptions of the procedures for extracting and analyzing the dichotomous sampler filters are outlined in Ontario Hydro Research Division Report 82-75-K. A systematic search for better detection limits for the autoanalyser methods was undertaken by Analytic Services. The resulting detection limits are listed in Table 3.4.1. Ion chromatography still has slightly better detection limits but the increased sample throughput (20:1) with the autoanalyser and reduced analysis and material costs (by one-third) more than outweigh the small loss in sensitivity. All filter extracts are presently analyzed with autoanalyser methods with improved sensitivity.

3.5 Meteorological Information

To facilitate episodic analyses and field data interpretation, synoptic parameters over the time periods of interest are required from weather observation stations that are close to the OHAAPN sites. Prior to the assessment program the required information was manually extracted from AES records. The Meteorology Section of the Resource Utilization Department in the Power System Operations Division of Ontario Hydro has a direct link to the AES daily meteorological information files. A request for twelve synoptic parameters at each of sixteen sites across the Province was made as part of the assessment and upgrading program. The sites and codes for which hourly meteorological information has been requested are listed in Appendix 3 in Table A3-1. The meteorological parameters requested for each site, along with the weather phenomena and symbols used in describing the present weather code (WX), are also given in Appendix 3, in Tables A3-2 and A3-3, respectively. Presently, daily summaries (every day of the week) for each of the sixteen sites are received on hard copy by the Atmospheric Research Section. The information is sorted by site and date and set aside for future applications. Computerization of this information is recommended as a result of the assessment.

This recommendation will be investigated in light of the acquisition of the HP87 minicomputer.

TABLE 3.4.1

ANALYTICAL METHODS AND DETECTION LIMITS USED IN THE
ONTARIO HYDRO AIR, AEROSOL AND PRECIPITATION MONITORING NETWORK

Parameter	Sample Type	Analytical Method	Filter Type	Detection Limit
pH	P ⁺	Glass Electrode	-	0.01 pH units
SO ₄ ⁼	A*	AA**	Coarse	0.13*
	A	AA	Fine	0.13*
	P	IC ⁺⁺	-	0.20 ⁺
NO ₃ ⁻	A	AA	Coarse	0.05
	A	AA	Fine	0.05
	P	IC	-	0.20
Cl ⁻	P	IC	-	0.20
NH ₄ ⁺	A	AA	Coarse	0.05
	A	AA	Fine	0.05
	P	AA	-	0.01
SO ₂	A	AA	Fine	0.46
NO ₃ ⁻ (volatile)	A	AA	Fine	0.05
Ca ²⁺	P	AAS ⁺⁺	-	0.05
Mg ²⁺	P	AAS	-	0.02
Na ⁺	P	AAS	-	0.02
K ⁺	P	AAS	-	0.02

* A - Aerosol + detection limit unit = µg/m³

+ P - Precipitation + detection limit unit = mg/l

** AA- Autoanalyser

++ IC- Ion Chromatography

++ AAS-Atomic Absorption Spectroscopy

3.6 Data Handling and Reporting

The number of air, aerosol and precipitation samples collected and analyzed since the inception of the survey in 1975 is enormous. During this time, changes in siting, sampling equipment, analytical methods and sensitivity and sampling protocol have greatly complicated the master data record to the point where information abstraction is a substantial problem. From the survey assessment it has been decided to unify all the available survey data into a single master data file with a consistent data record format and sample analysis units (ie: mg/l = parts per million for precipitation and $\mu\text{g}/\text{m}^3$ for air and aerosol data.)

It has also been decided that the survey data files will be transferred to the new Atmospheric Research Section HP87 mini-computer system to save on computer costs and permit easier access for detailed data interpretation.

The survey assessment pointed out the need to develop a consistent methodology for producing data reports. The units used in the reports were standardized for the precipitation samples as microequivalents per litre and for air/aerosol samples as micrograms per cubic meter, respectively. Ontario Hydro Research Division Report C82-81-K is the first to utilize the new format. Some other minor cosmetic adjustments were suggested as a result of the assessment. Future survey data reports will incorporate the changes.

4.0 REMAINING TASKS AND PROBLEMS

In terms of regionally representative sites, field equipment, sampling schedules, and analytical techniques, the survey is satisfactory. The work that remains to be completed is the portion of the assessment plan dealing with the reporting and reliability of the data garnered from sample analysis. The problems are as follows:

- (a) gaseous nitric acid and sulfur dioxide losses within the modified dichotomous sampler are unknown quantities. To reliably report volatile nitrate and sulfur dioxide concentrations these losses must be known.
- (b) the quality assurance and quality control of the Ontario Hydro survey data are essential for future meaningful interpretations. A statistical basis is needed for predicting the quality and representativeness of the data.
- (c) wear and tear of the interaction between the dichotomous sampler baseplate threads and retaining rings is recognized as a problem. If the survey is to operate past the middle of 1983 then the problem will have to be monitored in detail and solutions proposed.
- (d) the meteorological information obtained on a daily basis for 1981 and 1982 requires sorting and binding. The computerization of this information will be undertaken with the acquisition of the HP87 minicomputer system.

- (e) computer programs to manage the environmental data are needed. These again will be produced once the minicomputer system becomes available.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The Ontario Hydro air, aerosol and precipitation network assessment and upgrading has involved a considerable expenditure in labour and material costs. Has all of this been worthwhile? Does Ontario Hydro have at its disposal the best available survey with the funds currently available to investigate the acid rain problem in Ontario? These questions will be answered over the next year as the survey results are gathered together. The following specific conclusions can be drawn as a result of the assessment:

- (a) the five remaining sampling sites at Orangeville, Dorset, Winchester, Mississagi and Kapuskasing are regionally representative.
- (b) precipitation sample recovery has increased and the frequency of sample contamination has been reduced by the implementation of removable plastic bags to line the collection buckets.
- (c) precipitation sampling equipment reliability in the field is much improved with the physical changes mentioned earlier.
- (d) precipitation volume and intensity gauges have been installed at sites where such information was previously unavailable.
- (e) the Sierra dichotomous samplers were modified to ensure the operation of the instrument over the vast range of climactic changes that occur over the year in Ontario. An increased sample recovery and an improvement in the operator handling was also noticed.
- (f) detection limits for the analyses of all the environmental samples were improved to the scientifically best available limits.
- (g) volatile nitrate losses on the coarse particle stream required monitoring and the addition of nylon filters to the coarse filter cassettes was enacted to investigate these losses.
- (h) daily summaries of hourly meteorological information for sixteen stations are being obtained from the Ontario Hydro Meteorology Section.
- (i) files of precipitation, air and aerosol data have been restructured for consistency and the quality assured.
- (j) computerization of the survey information and of the meteorological data will be performed when the HP87 minicomputer becomes accessible in order to streamline the data handling and access.

- (k) the data reporting formats have been standardized to clarify the survey results for publication purposes.
- (l) the Ontario Hydro field sampling protocols are very similar to those of the Ontario Ministry of the Environment and Atmospheric Environment Service of Environment Canada.
- (m) Ontario Hydro and the other agencies in Canada are using the Sangamo Type A collector as one of the standard precipitation collectors.
- (n) all three agencies use similar air/ aerosol filter cassette configurations but the actual air and aerosol samplers employed are different. Future intercomparisons involving air and aerosol sampling will be required to evaluate the compatibility of the data.

An environmental monitoring program is a dynamic research tool. The many parameters involved are continually being modified and improved as the various organizations involved continue to operate such networks. What one considers as an up-to-date, state-of-the-art method today, may be obsolete in a year's time, therefore assessments and upgradings should be treated as ongoing processes. In the case of the Ontario Hydro network, the present evaluation and upgrading has been a success with only a few tasks remaining to be completed.

With monitoring networks being dynamic systems, recommendations for additional work or study in the future is a natural step. For the Ontario Hydro network the following recommendations are suggested:

- (a) a concise manual clearly describing the complete operation of the Ontario Hydro network is needed to bring together all the facets that are involved in operating our network.
- (b) field operator effectiveness and consistency is a major component in obtaining good, reliable field samples. More frequent field visits are suggested in order to closely monitor the operators for field technique so that any problems that occur can be corrected before a significant number of samples are invalidated.
- (c) the detailed laboratory evaluation of the nitric acid losses to the walls of the modified Sierra dichotomous sampler should be expanded to include SO_2 . Preliminary intercomparison results indicated that Ontario Hydro nitrate and SO_2 results are lower than either the OME and AES measurements.
- (d) intra-site comparisons of precipitation and air/aerosol measurements are recommended for the evaluation of the reproducibility/equivalency of the collectors that are operated in the Ontario Hydro survey.
- (e) utilization of the environmental data with the HP87 minicomputer system is suggested in order to reduce mainframe computer costs, and to provide the data interpreter with better hands-on experience with the survey information.

- (f) redesigning of the filter cassette, retaining collar and sampler baseplate is required for the dichotomous sampler to reduce wear on the threaded parts and to ensure reliable operation past the middle of 1983.

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APPENDIX 1

SITE DESCRIPTIONS AND LOCATIONS

A-1 Kapuskasing

The site is situated at Ontario Hydro's Kapuskasing area office, just north of Highway 11, on the western edge of town. The main office is set back approximately 60 m from the highway and has grass frontage. Approximately 15 m east is the Ministry of Natural Resources building and west of the area office is a paved parking lot for about 30 m. North of the site is a large enclosed compound for the storage of lineman's trucks and materials. The surface is loose gravel, beyond this is bush and marsh. South of the highway is bush in all directions. The nearest local pollution source is the Abitibi-Price Pulp and Paper mill, 3.2 km east. The monitoring equipment is located on the front lawn, 10 m to the west of the area office.

Mercator Coordinates: 5007000 mN; 530400 mE
Latitude and Longitude: 45° 12.4'; 79° 20.4'
Elevation: 308 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler
(3) Weathertronics heated snow and rain gauge

Operated by: Ontario Hydro personnel

A-2 Mississagi

The site is located at Ontario Hydro's Mississagi Transformer Station, 0.5 km north of the Raynor Dam, 30 km northwest of the Town of Thessalon. The station is in an enclosed compound (140 m x 180 m) with a mixed gravel and pebble surface. The surrounding area is bush and rock. The monitoring equipment is located on a large open area (30 m x 40 m), south of the main transformer building.

Mercator Coordinates: 5144300 mN; 317200 mE
Latitude and Longitude: 46° 25.8'; 83° 22.8'
Elevation: 229 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler

Operated by: Ontario Hydro personnel

A-3 Dorset (Muskoka)

The Ontario Hydro sampling equipment is located at the Ontario Ministry of the Environment intercomparison site which is located approximately 2 km from Dorset along Highway 117. The instrumentation is located in the middle of approximately a 1 km² area covered by grass and low level foliage. The surrounding area, in all directions, is wooded hills and bush.

Mercator coordinates: 5009600 mN; 662500 mE
Latitude and Longitude: 45° 13.5'; 78° 55.8'
Elevation: 320 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler

Operated by: OME personnel

A-4 Winchester

This site is located in the backyard of a private residence adjacent to the Ontario Hydro Regional office in Winchester. The monitoring equipment is on a grassy area (30 m x 40 m) surrounded by suburban residences on three sides and open fields on the other. Flat, agricultural land surrounds the town site. The village itself is approximately 1600 people with the Ontario Hydro regional office located on the southern edge.

Mercator Coordinates: 4992500 mN; 472400 mE
Latitude and Longitude: 45° 5.2'; 75° 21.1'
Elevation: 76 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler
(3) Weathertronics heated snow and rain gauge

Operated by: Land owner (retired Ontario Hydro personnel)

A-5 Orangeville

Located at Ontario Hydro Conference and Development Center on the Niagara Escarpment above the Hockley Valley, 8 km northeast of Orangeville. The monitoring station is located on the southern perimeter of the approximately 1 km² area. The surrounding area, in all directions is mostly open, grassy fields, some low-level buildings to the north.

Mercator Coordinates: 4869200 mN; 577500 mE
Latitude and Longitude: 43° 58.4'; 80° 2.0'
Elevation: 419 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler
(3) Weathertronics heated snow and rain gauge

Operated by: Ontario Hydro personnel

A-6 Essex

This site is located at the Ontario Hydro area office in the Town of Essex, which is located 24 km southeast of Windsor. The site is a small grassy area, 20 x 11 m with the office building on the western perimeter, a gravel yard to the north and an open field to the south and west. Sampling at the site was terminated at the end of August, 1982 as the site location had deteriorated to the point where air/aerosol and precipitation samples would have a high probability of local contamination.

Mercator Coordinates: 4670200 mN; 350100 mE
Latitude and Longitude: 42° 10.3'; 82° 48.9'
Elevation: 195 m
Instrumentation: (1) Wet-only Sangamo precipitation collector
(2) Modified Sierra dichotomous air/aerosol sampler

Operated by: Ontario Hydro personnel

APPENDIX 2

MODIFICATIONS OF THE MODEL 244 SIERRA DICHOTOMOUS AIR/AEROSOL SAMPLER

Figure 3.4 illustrates the dual module Model 6021 Sierra dichotomous sampler originally used in the network. Figure A2-1 displays the modified instrument from two different views. The rebuilt sampler is a single enclosed unit with overall box dimensions of depth = 0.610 m; height = 0.610 m and width = 0.914 m. The sampling head is located 0.965 m above the top of the box and the entire unit is supported on 0.925 m legs. The sampling intake is then 2.50 m from ground level. The inside of the instrument is insulated with Styrofoam SM insulation. A complete list of additional equipment used to complete the sampler modifications is given in Table A2-1. Figure A2-2 provides a schematic circuit diagram of the electrical circuit and component changes and additions made to the modified dichotomous sampler. Figure A2-3 displays the sample air flow schematic for the control portion of the modified Sierra dichotomous sampler.

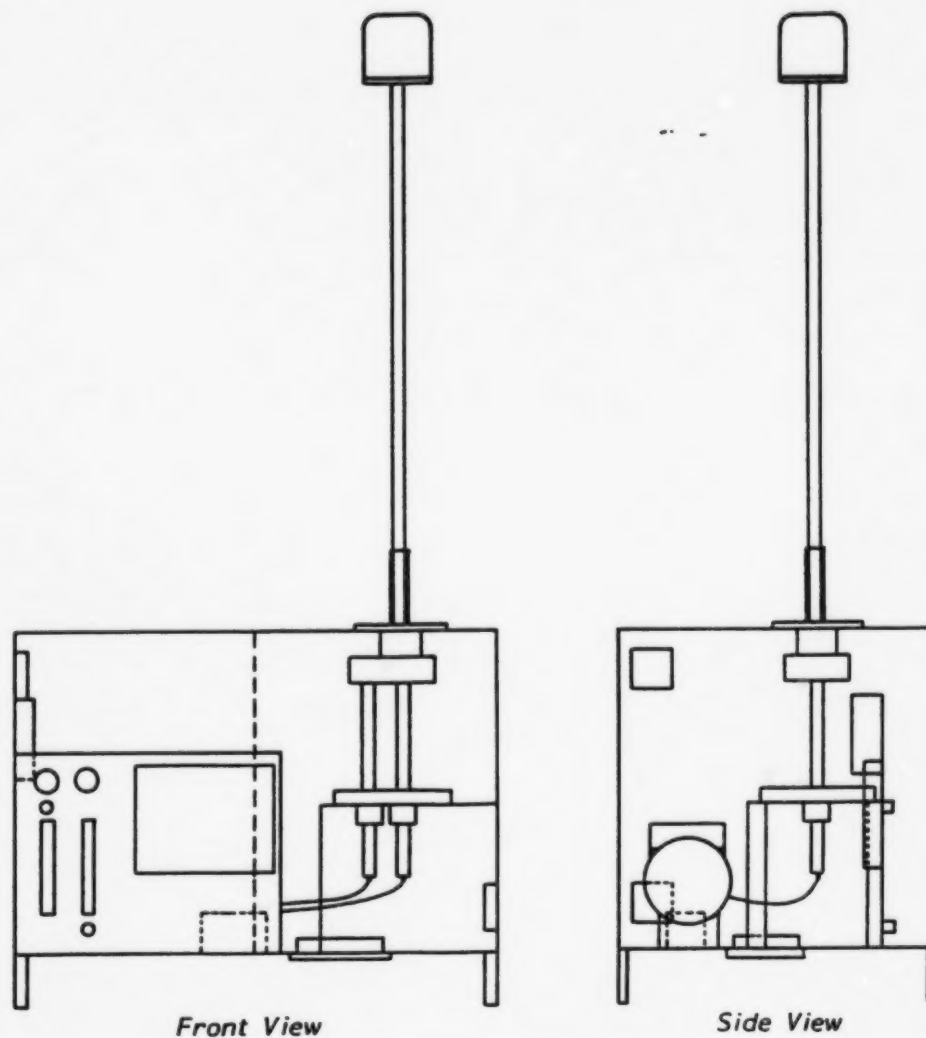


FIGURE A2-1
FRONT AND SIDE VIEWS OF MODIFIED MODEL 244
SIERRA DICHOTOMOUS SAMPLER WITHOUT THE EXTENSION LEGS

TABLE A2-1

ADDITIONAL EQUIPMENT USED IN THE MODIFICATION
OF THE SIERRA DICHOTOMOUS SAMPLING SYSTEM

- (A) one coiled bulk thermostat Model A19BBC-2 from Pena Johnson
- (B) two GMW 3-amp fuses
- (C) two mini-slide pilot lights Model 3011
- (D) two push button switches Model 8N1011
- (E) three Roton Sprite fans Model SU2A1
- (F) one Roton Blower Model BT2A1
- (G) two Wattlow Cartridge heaters Model L3A82 from Zesta Engineering
- (H) additional materials: (1) Styrofoam SM (0.025-m thick) insulation
(2) Polyethylene tubing
(3) All brass Swaglock connectors and fittings

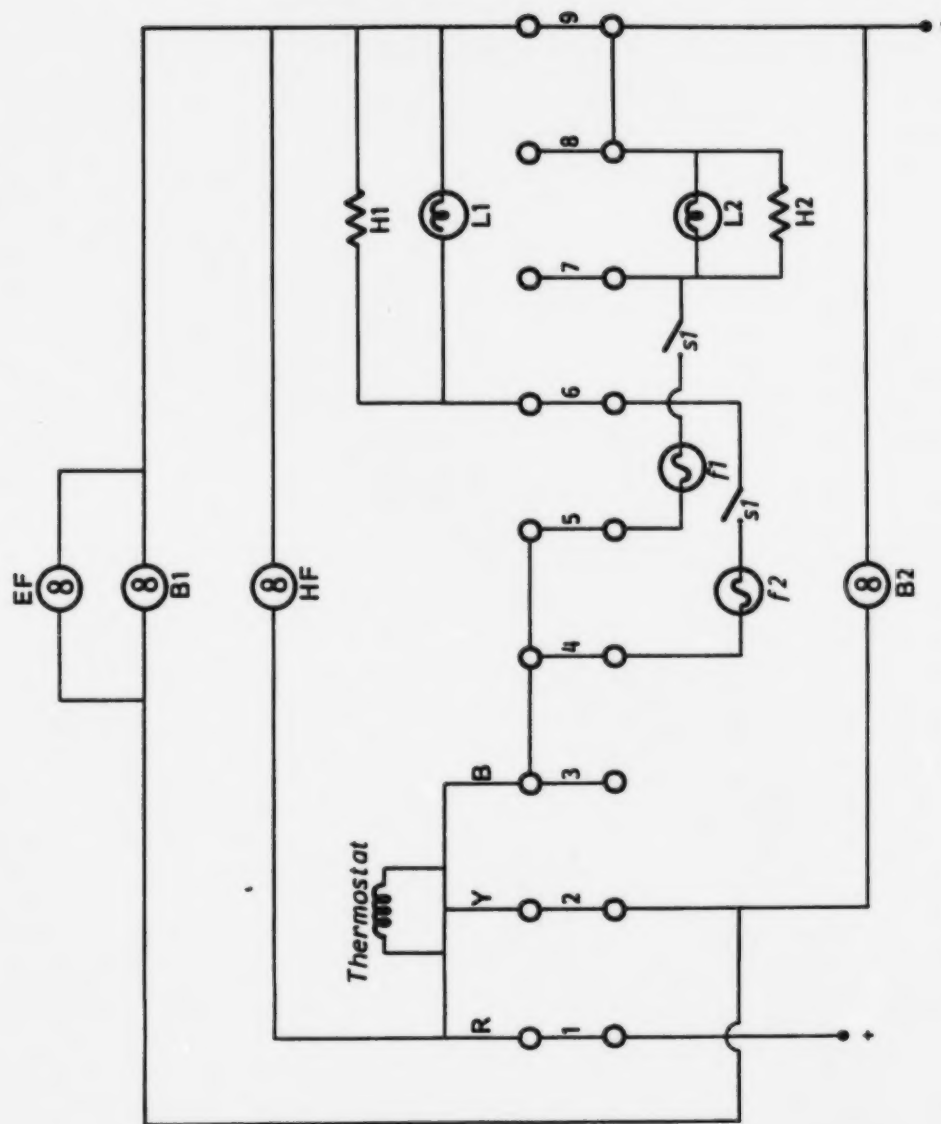


FIGURE A2-2
SCHEMATIC CIRCUIT DIAGRAM FOR COMPONENTS
ADDED TO SIERRA DICHOTOMOUS SAMPLER

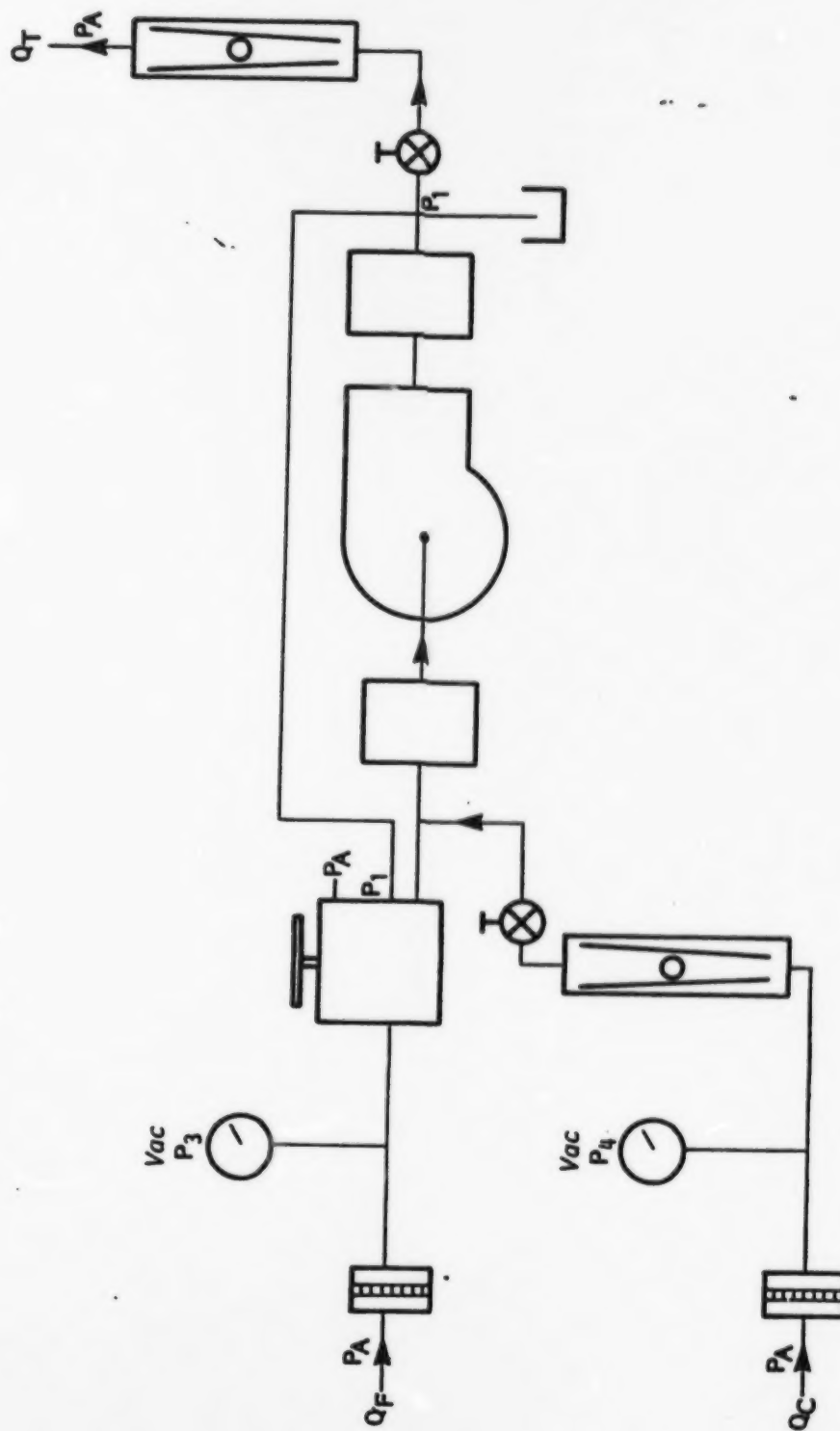


FIGURE A2-3
FLOW SCHEMATIC OF THE CONTROL PORTION OF THE SAMPLER

APPENDIX 3

METEOROLOGICAL STATIONS, INDICES AND SYMBOLS

TABLE A3-1METEOROLOGY STATIONS - CLASS I

<u>SITE CODE</u>	<u>SITE</u>
YQG	Windsor, Ont
YYZ	Toronto Int'l A., Ont
WLS	Mount Forest, Ont (automatic)
WCU	Barrie, Ont (automatic)
YGK	Kingston, Ont
YUL	Montreal, Dorval Int'l A., Que
YOW	Ottawa, Int'l A., Ont
YQA	Muskoka, Ont
WBI	Britt, Ont
YYB	North Bay, Ont
YSB	Sudbury, Ont
SSM	Sault Ste Marie, MI
YXZ	Wawa, Ont
YTS	Timmins, Ont
YYU	Kapuskasing, Ont
WNZ	Nagagami, Ont (automatic)

TABLE A3-2

INDEX TO HOURLY WEATHER DATA

- WX → Present Weather - refer to attached sheet for explanation of letter codes
- PM → Mean Sea Level Pressure in millibars (mb) $\times 10^{-1}$
(ie, 10191 = 1019.1 mb)
- T → Air Temperature ($^{\circ}\text{C}$)
- P6 → Precipitation Total in last 6 hours in mm
- RH → Relative Humidity expressed as a %
- WS → Wind Speed expressed in km/h
- WD → Wind Direction
direction varies from 0° to 360°
 0° = calm, 90° = east, 180° = south, 270° = west, 360° = north
- MSG → Missing Data
- P2 → Precipitation Total in last 24 hours (running total)
- TX → Air Temperature - maximum
- TN → Air Temperature - minimum
- TD → Temperature - dewpoint
- VI → Visibility in 0.1 km increments

TABLE A3-3

WEATHER AND OBSTRUCTIONS TO VISION
WEATHER PHENOMENA AND SYMBOLS

<u>General Category</u>	<u>Specific Phenomena</u>	<u>Symbol</u>
Tornados and Thunderstorms	Tornado, Waterspout, Funnel Cloud, Thunderstorm	Tornado, Waterspout, Funnel Cloud, T, T+.
Precipitation	Rain	R--, R-, R, R+
	Rain Shower	RW--, RW-, RW, RW+
	Drizzle	L--, L-, L, L+
	Freezing Rain	ZR--, ZR-, ZR, ZR+
	Freezing Drizzle	ZL--, ZL-, ZL, ZL+
	Snow	S--, S-, S, S+
	Snow Grains	SG--, SG-, SG, SG+
	Ice Crystals	IC
	Ice Pellets	IP--, IP-, IP, IP+
	Ice Pellet Showers	IPW--, IPW-, IPW, IPW+
	Snow Showers	SW--, SW-, SW, SW+
	Snow Pellets	SP--, SP-, SP, SP+
	Hail	A--, A-, A, A+
Obstructions to Vision (visibility 6 miles or less)	Fog	F
	Ice Fog	IF
	Haze	H
	Smoke	K
	Blowing Snow	BS
	Blowing Sand	BN
	Blowing Dust	BD
	Dust Haze	D

POOR

QUALITY

ORIGINAL